

REMARKS

Office Interview

As an initial matter, applicant wishes to sincerely thank the Examiner for granting a personal interview to discuss the instant invention on July 30, 2008. A copy of the Examiner's Interview Summary is attached with this amendment for reference. In the July 30 interview, applicant presented samples of embodiments of the instant invention and discussed differences between the instant invention and conventional "legacy" techniques for achieving integration among cells. In addition, claim language distinguishing from several prior art documents was proposed by applicant. Examiner also explained to applicant his rationale for prior claim rejections.

Correction

Applicant wishes to point out an error in the last paragraph of the "Remarks" section of the Amendment filed July 25, 2008. There the claim numbering was stated in error and the total number of claims was also erroneously stated as totaling 26. The last paragraph of the instant Supplemental Amendment properly states the claim numbers and total.

Brief Analysis Of The Cited References

In the U.S. Patent Office Action mailed March 27, 2008, the examiner rejected all pending claims using various combinations of four references as follows.

U.S. Patent 5,185,042 (Ferguson)
U.S. Patent 3,764,280 (Lupinski)
U.S. Patent 4,087,960 (Koichi)

Singh, V.P. et al., "Thin film CdTe-CdS heterojunction solar cells on lightweight metal substrates", Sol. Energy Mater. Sol. Cells, 59, 145-161, (1999).

(1) U.S. Patent 5,185,042 (Ferguson)

Ferguson teaches printed circuit substrate for interconnecting multiple back contact photovoltaic cells (contacts of opposite polarity are located on the back surface of the cells) The printed circuit is stated to comprise electrical traces on an "epoxy glass" substrate (col. 3, ln. 12), a high temperature, rigid composite material comprising glass fiber in a rigid, cured epoxy resin conventionally employed for printed circuits (see Wikipedia, FR-4 for PCB). A common term for such composites is "fiberglass". The photovoltaic cell contacts are intended to be soldered to the printed circuitry (col. 3, ln. 46) which would require such a high temperature substrate, one which would not melt at typical soldering temperatures. It is clear that the "epoxy glass" substrates of Ferguson are not intended or taught to have adhesive surface characteristics.

(2) U.S. Patent 3,764,280 (Lupinski)

Lupinski teaches a process to render a surface comprising a polymer electrically conductive to enable subsequent metal plating. The surface is formed by an elastomeric polymer heavily filled with a specific particulate metal oxide, such as cadmium oxide. Connecting the surface to a source of cathodic potential in an alkaline electrolyte causes reduction of the oxide to metal. The reduction initiates at the cathodic contact and gradually progresses laterally over the surface and to some extent into the interior of the coating. Following reduction, the metal may be electroplated.

(3) U.S. Patent 4,087,960 (Koichi)

Koichi teaches use of a flexible printed circuit for interconnecting multiple cells whose electrical contacts are disposed on the same side of the cells. The cell contacts are in the form of raised "bumps" of gold or solder for soldering to the traces of the printed circuit. Because of the soldering requirement, the flexible substrate must be formed from a high temperature polymer. See col. 3, lines. 8-10, where it states "The circuit board is preferably made of a thermostable high polymer, a preferred high polymer being a polyimide."

(4) Singh, V.P. et al., "Thin film CdTe-CdS heterojunction solar cells on lightweight metal substrates", Sol. Energy Mater. Sol. Cells, 59, 145-161, (1999)

The reference teaches formation of CdTe-CdS cells on a Molybdenum substrate approximately .004 inch thick. A transparent electrode (ITO or ZnO) is used to collect current from the light incident face.

Detailed Analysis Of Instant Claims

Amended Independent Claims 19, 41 and 44

Overall Comment: Independent claims 19, 41, and 44 have now been amended to all claim a combination of a light incident surface of a photovoltaic cell and a current collector structure. This is an effort to limit the extent of the Examiner's search in the instant application.

Amended Claim 19: The claim has been amended to essentially combine prior claim 26 with prior claim 19. The newly amended claims adds the important new limitation that a portion of the first substrate surface is formed by a polymeric adhesive. This essentially combines old claims 26 and 19 and replaces "comprising" with "formed by" as discussed in the 07/30/2008 Office Interview. The examiner rejected the combination of old claims 26 and 19 in his 03/27/08 Office Action at two spots. First, he stated in the second paragraph of page 9 that "the conductive polymer of Lupinski adheres to the substrate surface and therefore reads on the instant polymeric adhesive". However, the claim now states that a portion of the first substrate surface is formed by a polymeric adhesive, not the first material forming a pattern on the surface. The corresponding "first substrate surface" of Lupinski could only be that surface of the "electrical insulating" plaques since the instant claim 19 further requires a first material comprising a polymer in a trace pattern overlaying the first substrate surface. If the elastomeric material of Lupinski were considered to form a portion of the first substrate surface, then there is no other polymeric material to form the "first material" required by instant claim 19. Lupinski teaches materials suitable for the plaques in Table II of the patent. They are all very rigid, high temperature polymers which in no way could be construed as adhesives. Further, Lupinski teaches his plaques are "molded" (see for example colm.10, line 56 of Lupinski 3,764,280). It is clear that Lupinski teaches away from using a polymeric adhesive to form surface portions of his plaques, since an adhesive surface would not permit separating the plaque from the mold.

Further, any combination of Lupinski with Koichi and/or Ferguson would not result in a portion of the first substrate surface formed by a polymeric adhesive". The cured rigid epoxy glass substrate surface of Ferguson and the stiff high temperature polyimide surface of Koichi are neither taught or suggested to have adhesive characteristics.

The Examiner further rejected old claim 26 at paragraph 3 of page 7 of the 03/27/08 action. There he states that "Figure 2c of Koichi shows polymeric adhesive 9 disposed on the surface of substrate 7. Adhesive 9 is shown bonding portions of substrate 7 directly to the surface of cells 1. (Figure 2c; Column 3, lines 22-30)." However, the instant amended claim 19 requires a portion of the first substrate surface formed by a polymeric adhesive and that the trace pattern and corresponding conductive pattern be positioned over the first substrate surface. If item 7 of Koichi is considered the substrate, then the "first substrate surface" on which conductive material 8 is positioned would be the

downward facing surface of 7. But that surface is formed by a polyimide, a material that certainly would not be considered a polymeric adhesive as discussed above.

If, on the other hand, adhesive 9 of Koichi is considered the substrate having a first surface portion formed by a polymeric adhesive, then the first substrate surface over which the first material trace pattern is positioned would have to be the upward facing surface or 9. But then the “electrically conductive material” replicating the first material trace pattern could not possibly be “positioned between said first material and the light incident surface” because the first material trace pattern could not overlay the light incident surface. Furthermore, the upward facing surface of 9 does not overlay the light incident surface of the cell as required by the instantly amended claim 19.

Similar analysis and logic applied to Fig 2d of Koichi results in a same conclusion that the instantly amended claim 19 cannot be read on that Figure 2d. In figure 2d, the first surface of claim 19 in facing relation to the light incident surface would have to be the downward facing surface of material 9 in Koichi, Figure 2d. But that surface can have no “second material positioned between said first material and said light incident surface” as required by instantly amended claim 19. In addition, in the Koichi Fig. 2d arrangement, the conductive material does not even overlay the light incident surface of the cells.

Amended Claim 41: In the 03/27/08 Office action, the Examiner combined Lupinski with either Ferguson or Koichi to reject claim 41. Claim 41 as instantly amended calls for the “first layer” to be of homogeneous cross sectional composition. This is clearly not the case with Lupinski. Lupinski creates a metallic surface capable of being further metal plated by first reducing a material comprising a metal oxide to a structure comprising elemental metal. However, his process does not create a layer of homogeneous cross sectional composition. See for example Lupinski at column 6, lines 44-49, where it says “The reduction into the layer occurs at a slower rate than the reduction on the surface. Therefore, when thick coatings or films are reduced either as a separate step or during the plating reaction, surface reduction will be completed first, but not to the exclusion of some reduction into the coating”.

These observations are very important. It is clear that following reduction Lupinski’s coatings do not have homogeneous cross sectional composition. It is obvious from this teaching that the Lupinski coating are either porous or “wick” chemical solution into the interior during the reduction and plating operations. This penetration of the electrochemical solutions into the bulk of the layer would be very detrimental, because the solutions probably could not be easily removed after processing. Having residual chemistry such as the taught cyanide solutions remaining in a final completed device would be highly detrimental to stability and even possibly health. Most likely, the presence of such electrolyte would set up electrochemical couples with subsequently plated metals. The electrolyte might well have deleterious effects on the solar cell itself, especially cells like CIGS which are known to be chemically sensitive.

The instantly amended claim states that the first layer is of substantially homogeneous cross sectional composition, clearly distinguishing in an important way from Lupinski.

Amended Claim 44: In the 03/27/08 Office Action, the Examiner rejected old claim 44 by combining Lupinski with either Koichi or Ferguson. Instantly amended claim 44

adds the limitation of “- said light incident surface characterized as being substantially planar and having substantially uniform surface composition”. Neither Koichi nor Ferguson have uniform composition on the surface overlayed by the conductive traces. Both have isolated contact regions of different polarity and therefore cannot possibly have uniform composition. Further, Koichi, at col. 2, lines 64-68 states “Conveniently, a bump 13 of gold or of solder is formed by conventional means on each of the electrode portions 6, it being desirable the bump 13 should protrude very slightly above the adjoining surface of solar cell 1. Finally, the bottom surface of Ferguson would not be the light incident surface over which the traces extend, called for in instantly amended claim 44.

Remarks Regarding Selected Dependent Claims

Claims 21 and 22: These claims were rejected on a combination of Ferguson, Lupinski and Singh et al. Singh et al. teach a thin film photovoltaic structure on a Molybdenum foil. There is no apparent teaching as to how current is collected from the light incident surface of the cell, except for the presence of a top transparent electrode (TCO). It is certainly unclear how the normally opaque (glass-epoxy) substrate of Ferguson could function as a current collector structure for the light incident surface of Singh et al. Moreover, the Ferguson structure does not actually serve as a current collector from the top light incident surface, but more as a structure to convey current from discrete contact points to which collected current has already been conveyed. The Ferguson structure would be useless if applied to a cell having a self-supporting metal foil rear electrode as claimed in currently amended claim 22 since the entire back surface is of the same polarity.

Claim 32 and claim 50: These claims have the limitation of “printed material”. The Examiner has taken a position that undue weight cannot be given to this limitation because this is a “product by process” limitation. Applicant argues that a “printed material”, while produced by a process, has by the very nature of the process a distinct structure. Thus, applicant disagrees with the Examiner’s position when considering the limitation of “printed material”. The process of printing intrinsically results in a structure, specifically a substantially two-dimensional form having a low profile. A “printed material” would be understood by plain language to have such structure. Therefore, applicant argues that “printed material” is intrinsically a structural limitation. Support for the “printed material” limitation of claims 32 and 50 can be found at Paragraph 23 (last sentence) and Paragraphs 198 and 199 of the Specification as filed.

Claims 39 and 40: Claims 39 and 40 call for a “low melting point metal based material” and “indium” respectively. The Examiner rejected claim 39, stating that copper, for example, is low melting point relative to several other metals. Applicant disagrees with Examiner’s position for two reasons.

1. When one looks for the meaning of a technical term, it should be that meaning commonly understood by one skilled in the art given normal comparisons. An engineer or scientist would not consider copper to be a "low melting point metal" except in the abnormal situation where he is asked to make a relative comparison with other high melting point metals. The plain, normal engineering understanding of "low melting point metal" is that having a melting point typical of a solder or lower. Typical solders melt at about 500 degree Fahrenheit or lower, so a metal or metal alloy that melted below about 500 degrees would be considered "low melting point" unless an abnormal comparative situation arose.
2. In the instant specification, at Paragraph 0204 of the published document, it is stated that
 - "Alternatively, one may employ a low melting point metal-based material as a constituent of the material forming surface 185. In this case the low melting point metal-based material is caused to melt during the process 177 of Figure 60 thereby increasing the contact area between the mating surfaces 185 and 59. In a preferred embodiment indium or indium containing alloys are chosen as the low melting point contact material at surface 185. Indium melts at a low temperature, considerably below possible lamination temperatures. In addition, Indium is known to bond to glass and ceramic materials when melted in contact with them. Given sufficient lamination pressures, only a very thin layer of Indium would be required to take advantage of this bonding ability."
 - Process 177 is shown to be a plastics laminating process. Such a process would be typically understood to be carried out at a temperature less than about 500 degree Fahrenheit. Thus, here again is a teaching that "low melting point metal or alloy" indicates a metal or metal based alloy whose melting point would be less than about 500 degree Fahrenheit.

Claims 52 and 53: These claims teach the incorporation of silver and carbon black respectively as a constituent of the "first material". It is noted that Lupinski teaches against the use of these materials (See Lupinski, Col. 2, line 37 through Col. 3, line 11.).

New Claim 55: This claim states that the silicon containing material is in the form of a barrier film. This is supported in Paragraph 0196 of the application publication.

Applicant states that the instant amendments to the claims bring them into condition for allowance. Following entry, claims will consist of independent claims 19, 41 and 44 and independent claims 21-22, 27, 29, 31-40, and 46-62. Total claims will be 34.

Entry of the instant Amendment and the Issuance of a Notice Of Allowance is respectfully requested.

If the Examiner does not agree with the Applicant's position that all pending claims are allowable or if the Examiner has any questions, suggestions or comments which would assist in allowance, the Examiner is respectfully requested to contact the undersigned to arrange a telephonic discussion of the claims prior to issuing an Office Action. Applicant's contact information is stated below.

Respectfully submitted,

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